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April 2007

Abstract

This paper proposes an original framework to determine the relative influence of five factors on the Feldstein and Horioka result of OECD countries with a strong saving-investment association. Based on panel threshold regression models, we establish country-specific and time-specific saving retention coefficients for 24 OECD countries over the period 1960-2000. These coefficients are assumed to change smoothly, as a function of five threshold variables, considered as the most important in the literature devoted to the Feldstein and Horioka puzzle. The results show that; degree of openness, country size and current account to GDP ratios have the greatest influence on the investment-saving relationship.

Keywords : Feldstein Horioka puzzle, Panel Smooth Threshold Regression models, saving-investment association, capital mobility .

J.E.L Classification: C23, F21, F32.

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1 Introduction

In their seminal article, Feldstein and Horioka (1980) provide evidence of a high correlation between domestic saving and domestic investment rates for OECD countries. This robust finding of positive saving–investment correlations has launched a debate regarding the degree of financial integration and openness within the industrialised world.

In this paper, we investigate the potential threshold effects in the relationship between national saving and domestic investment rates. The baseline idea is very simple: common knowledge that international mobility of capital depends on other exogenous variables (trade openness, country size, demography, etc.) clearly matches the definition of a threshold regression model: "threshold regression models specify that individual observations can be divided into classes based on the value of an observable variable" (Hansen, 1999, page 346). Thus, we propose to test the relevance of breaking down the Feldstein and Horioka (FH thereafter) regression parameters (or saving-retention coefficients) into classes given the values of five main factors generally quoted in this literature: (i) economic growth, (ii) demography, in particular dependency ratios, (iii) degree of openness, (iv) country size and (v) current account balance.

In a panel data context, the simplest way to introduce threshold effects consists in using a Panel Threshold Regression (PTR) Model proposed by Hansen (1999). This model assumes a transition from one regime to another depending on the value of a threshold variable (the trade openness for instance). In a model with two regimes, if the threshold variable is below a given value, called the threshold parameter, the domestic investment is defined by one equation (with a particular value of the saving-retention coefficient), while it is defined by another equation (with another saving-retention coefficient) if the threshold variable exceeds this threshold parameter. This model has been used by Ho (2003) to empirically re-evaluate the country-size argument for the FH puzzle. In his approach, country-size is modelled as the threshold variable, so that the saving-retention coefficients are then distinguished by differing country-size regimes. However, one of the main drawbacks of this PTR model is that it allows only for a small number of classes, i.e. of saving-retention coefficients. This implicit assumption may be suitable for the country-size effect since generally the economist only distinguishes between “small” and “big” countries depending on the value of their GDP (Murphy, 1994). On the contrary, the influence of growth or trade openness on the magnitude of the saving-retention coefficient may be more subtle.

The alternative solution adopted in this paper consists in using a Panel Smooth Threshold Regression (PSTR) model recently developed by Gonzalez, Teräsvirta and Van Dijk (2004) and Fok, Van Dijk and Franses (2004). Two interpretations of these models are possible. On the one hand the PSTR can be thought of as a regime-switching model that allows for a small number of extreme regimes (saving-retention coefficients) associated with the extreme value of a transition function and where the transition from one regime to another is smooth. On the other hand, the PSTR model can be used to allow for a "continuum" of regimes (saving-retention coefficients), each one being characterised by a different value of the transition variable. The logic is then similar to that developed in the standard univariate time series STAR.

Our approach has two main advantages. First, based on PSTR specifications, we derive saving-retention coefficients, which vary not only between countries but also with time. Thus, our work provides a simple parametric approach to capture both cross-country heterogeneity and time variability of the saving–investment correlations. Second, our approach allows for smooth changes in country-specific correlations depending on a threshold variable. Consequently, we consider the five potential threshold variables previously mentioned as potential explanations of the cross-country heterogeneity and/or the time variability of saving-retention coefficients for OECD countries and we then compare the corresponding estimated FH parameters. This comparative dimension of our approach is particularly important since studies on the saving–investment relationship have been conducted along a number of divergent methodological approaches and have come to varying conclusions regarding the interpretation of findings. For instance, Taylor (1994) found no correlation between domestic investment share in GDP and ratio of domestic saving to GDP, when controlling the FH cross-section regression for relative domestic prices, age pyramid and interaction between dependency and growth rates. Using a 17 OECD countries sample, Murphy (1984) obtained significantly different saving-retention coefficients depending on country size[1]. Nevertheless, no one has ever assessed the relative influence of each of these variables on saving–investment correlations. On the contrary, our panel threshold regression framework allows establishing a “ranking” for the most frequently quoted explicative factors.

[1]These diverging coefficients have also been found by Feldstein and Horioka (1980), and then confirmed by Tesar (1991), Baxter and Crucini (1993), Obstfeld (1995), Coakley et al. (1998) and Ho (2003).

The rest of the paper is organised as follows. In the next section, we discuss the threshold specification of FH regression and particularly, the cross-country heterogeneity and the time variability of saving retention coefficients. The choice of the threshold variable, linearity tests and estimates for the parameters are then presented in a third section. The fourth part of the paper is given over to the results of the linearity tests and the estimates obtained from various panel threshold models. Finally, based on these PSTR estimates, we calculate the individual FH parameters and discuss the relative influence of the various threshold variables. A last section concludes.

2 The Feldstein-Horioka puzzle: Toward a Threshold Specification

The basis of our empirical approach is exactly the same as that used by many authors since the seminal paper of Feldstein and Horioka (1980). It consists of evaluating the mobility of capital for a panel of N countries. The corresponding model is then defined as follows:

$$I_{it} = \alpha_i + \beta S_{it} + \epsilon_{it} \tag{1}$$

where I_{it} is the ratio of domestic investment to GDP observed for the i^{th} country at time t, S_{it} is the ratio of domestic savings to GDP and α_i denotes an individual fixed effect. The residual ε_{it} is assumed[2] to be $i.i.d. \, (0, \sigma_\varepsilon^2)$. Used in particular by Corbin (2001), and more generally in all the cross-section specifications of the FH regression, this model has two major drawbacks. Firstly, it assumes the same degree of international mobility of capital across the N countries of the panel, i.e. $\beta_i = \beta, \forall i = 1, .., N$. It is obvious that this assumption is unrealistic even when considering only OECD countries. As previously mentioned, many factors have been identified that clearly affect the capital mobility: country size, age structure of population, degree of openness, etc. So, the assumption $\beta_i = \beta$ implies that these factors do not affect capital mobility. Such an assumption is obviously too restrictive. Besides, when it comes to including these factors as additional explanatory variables in the regression model (1), the problem remains unsolved: the conditional relationship between

[2] Many FH models in the literature have been dynamic. If using a static model is understandable, it also is restrictive. In particular, the residual are assumed to be non serially correlated. This assumption is however required when one comes to extend this specification to panel threshold models since the PTR and PSTR models can not include a lagged endogenous variable as explicative variable (Hansen, 1999).

investment and saving is assumed to be homogeneous as long as β_i is common for all i.

Secondly, equation (1) implies that the saving retention coefficient is constant for the set time period of the model. This assumption is particularly unrealistic considering the obvious implications of macro-panels with a large enough time dimension. That is to say, it is obvious that capital mobility in a typical OECD country was not the same in the 1960s as in the 1990s. With the removal of capital controls and barriers to the movement of capital across borders, since the mid 1970s in major OECD countries, the FH coefficient can be described as time-decreasing. In fact, Obstfeld and Rogoff (2000) find a saving retention coefficient of 0.60 in a cross-county regression for OECD countries for the period 1990-1997, compared to 0.89 highlighted by FH in their seminal article for 16 OECD countries during the period 1960-74. So, there is no reason to assume that parameter β (parameters β_i) is (are) time invariant. Generally, heterogeneity and time variability issues cannot be dealt with at the same time. For instance, it is possible to consider a heterogeneous panel model by assuming that the FH parameters β_{it} are randomly distributed (for a presentation of random coefficients models, see Hsiao and Pesaran, 2004). But in practice, in many specifications used, these parameters are assumed to be constant over time. Besides, in a simple random coefficient model (Swamy, 1970), parameters β_i are assumed to be independent from the explanatory variables. In other words, the FH coefficients are assumed to be independent from the ratio of domestic saving to GDP. Thus, their variability is the consequence of other unspecified structural factors.

One solution to circumvent both these issues consists in introducing threshold effects in a linear panel model. In this context, the first solution requires using a simple Panel Threshold Regression (PTR) model (Hansen, 1999) as suggested by Ho (2003). In this case, the transition mechanism between extreme regimes is very simple: at each date, if the threshold variable observed for a given country is smaller than a given value, called the threshold parameter, capital mobility is defined by a particular model (or regime); this regime is different from the model used if the threshold variable is larger than the threshold parameter. For instance, let us consider a PTR model with two extreme regimes:

$$I_{it} = \alpha_i + \beta_0 S_{it} + \beta_1 S_{it}\; g(q_{it}; c) + \epsilon_{it} \tag{2}$$

where q_{it} denotes a threshold variable, c a threshold parameter and where the transition function $g(q_{it}; c)$ corresponds to the indicator function:

$$g(q_{it}; c) = \begin{cases} 1 & \text{if}\, q_{it} \geq c \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

With such a model, the FH coefficient is equal to β_0 if the threshold variable is smaller than c and is equal to $\beta_0 + \beta_1$ if the threshold variable is larger than c. This model can be extended to a more general specification with r regimes. However even in this case, the PTR model imposes that the value of the saving retention coefficient can be divided into a (small) finite number of classes. Such an assumption may be unrealistic even for OECD countries.

As usual in the literature, the solution to this problem requires the use of a model with a smooth transition function. This type of model has recently been extended to panel data with the Panel Smooth Threshold Regression (PSTR) model proposed by Gonzàlez et al. (2005) and Fok et al. (2004). Let us first consider the simplest case with two extreme regimes and a single transition function:

$$I_{it} = \alpha_i + \beta_0 S_{it} + \beta_1 S_{it}\ g(q_{it}; \gamma, c) + \epsilon_{it} \tag{4}$$

In this case, the transition function is a continuous and bounded function of the threshold variable. Gonzàlez et al. (2005), following the work of Granger and Teräsvirta (1993) for the time series STAR models, consider the following logistic transition function:

$$g(q_{it}; \gamma, c) = \frac{1}{1 + \exp\left[-\gamma(q_{it} - c)\right]} \quad, \gamma > 0 \tag{5}$$

where c denotes a location parameter and parameter γ determines the slope of the transition function. For our purposes, this PSTR model has a great advantage: it allows parameters (and consequently capital mobility) to vary across countries (heterogeneity issue), but also with time (stability issue). More precisely, it provides a parametric approach of the cross-country heterogeneity and of the time instability of the FH coefficients, since these parameters change smoothly as a function of a threshold variable. More precisely, the FH coefficient is defined as a weighted average of parameters β_0 and β_1. For instance if the threshold variable q_{it} is different from the ratio of domestic saving to GDP, the FH coefficient for the i^{th} country at time t is defined by:

$$e_{it} = \frac{\delta I_{it}}{\delta S_{it}} = \beta_0 + \beta_1\ g(q_{it}; \gamma, c) \tag{6}$$

Given the properties of the transition function, we have $\beta_0 \leq e_{it} \leq \beta_0 + \beta_1$ if $\beta_1 > 0$ or $\beta_0 + \beta_1 \leq e_{it} \leq \beta_0$ if $\beta_1 < 0$. Consequently, this PSTR model allows for an evaluation of the influence of variable q_{it} on capital mobility. By comparing various PSTR specifications with different transition variables, it is possible to identify the most important factors that could explain the cross-country heterogeneity of capital mobility.

It is important to note that the degree of capital mobility in a PSTR can be different from the estimated parameters for extreme regimes, i.e. parameters β_0 and β_1. As illustrated by equation (6), these parameters do not directly correspond to the FH parameter. Parameter β_0 corresponds to the FH coefficient only if the transition function $g(q_{it};\gamma,c)$ tends towards 0. The sum of the β_0 and β_1 parameters corresponds to the FH coefficient only if the transition function $g(q_{it};\gamma,c)$ tends towards 1. Between these two extremes, the FH coefficient is defined as a weighted average of parameters β_0 and β_1. Therefore, it is important to note that it is generally difficult to directly interpret the values of these parameters (as in a probit or logit model). It is generally preferable to interpret (i) the sign of these parameters, which indicates an increase or a decrease in the FH coefficient depending on the value of the threshold variable and (ii) the varying coefficient in the time and individual dimensions given by equation 6.

Finally, this model can be analyzed as a generalisation of the PTR model used by Ho (2003) and the panel linear model with individual effects used by Corbin (2001). On Figure 1 the transition function is displayed for various values of the slope parameter γ. When the γ parameter tends to infinity, the transition function $g(q_{it};\gamma,c)$ tends towards the indicator function (equation 3). Thus, when γ tends to infinity the PSTR model corresponds to the PTR model (Hansen, 1999). When γ tends to zero, the transition function $g(q_{it};\gamma,c)$ is constant and the model corresponds to the standard linear model with individual effects (so-called "within" model), i.e. with constant and homogenous FH coefficients. The coefficient is then simply defined by $e_{it}=\beta_0$, $\forall i=1,...,N$ and $\forall t=1,...,T$.

The PSTR model can be generalised to $r+1$ extreme regimes as follows:

$$I_{it}=\alpha_i+\beta_0 S_{it}+\sum_{j=1}^{r}\beta_j S_{it}\ g_j(q_{it};\gamma_j,c_j)+\epsilon_{it} \tag{7}$$

where the r transition functions $g_j(q_{it};\gamma_j,c_j)$ depend on the slope parameters γ_j and on location parameters c_j. In this generalisation, if the threshold variable q_{it} is different from S_{it}, the FH coefficient for the i^{th} country at time t is defined by the weighted average of the $r+1$ parameters β_j associated to the $r+1$ extreme regimes:

$$e_{it}=\frac{\delta I_{it}}{\delta S_{it}}=\beta_0+\sum_{j=1}^{r}\beta_j\ g_j(q_{it};\gamma_j,c_j) \tag{8}$$

The expression of the FH coefficient is slightly different if the threshold variable q_{it} is a function of the ratio of domestic saving to GDP. For instance, if we assume that the threshold variable corresponds to the ratio of domestic saving to GDP, i.e. $q_{it} = S_{it}$, the expression of the FH coefficient is then defined as:

$$e_{it} = \frac{\delta I_{it}}{\delta S_{it}} = \beta_0 + \sum_{j=1}^{r} \beta_j \ g_j(q_{it}; \gamma_j, c_j) + \sum_{j=1}^{r} \beta_j \ \frac{\delta g_j(q_{it}; \gamma_j, c_j)}{\delta S_{it}} S_{it} \tag{9}$$

3 Estimation and Specification Tests

The estimation of the parameters of the PSTR model consists of eliminating the individual effects α_i by removing individual-specific means and then in applying non linear least squares to the transformed model (see Gonzàlez et al., 2005 or Colletaz and Hurlin (2006), for more details). Gonzàlez et al. (2005) propose a testing procedure in order (i) to test the linearity against the PSTR model and (ii) to determine the number, r, of transition functions, i.e. the number of extreme regimes which is equal to $r+1$. Testing the linearity in a PSTR model (equation 4) can be done by testing $H_0 : \gamma = 0$ or $H_0 : \beta_0 = \beta_1$. But in both cases, the test will be non standard since under H_0 the PSTR model contains unidentified nuisance parameters. This issue is well known in the literature devoted to time series threshold models (Hansen, 1996). A possible solution is to replace the transition function $g_j(q_{it}, \gamma_j, c_j)$ by its first-order Taylor expansion around $\gamma = 0$ and to test an equivalent hypothesis in an auxiliary regression. We then obtain:

$$I_{it} = \alpha_i + \theta_0 \ S_{it} + \theta_1 \ S_{it} \ q_{it} + \epsilon^*_{it} \tag{10}$$

In this first-order Taylor expansion, parameters θ_i are proportional to the slope parameter γ of the transition function. Thus, testing the linearity of the FH model against the PSTR simply consists of testing $H_0 : \theta_1 = 0$ in this linear panel model. If we denote SSR_0 the panel sum of squared residuals under H_0 (linear panel model with individual effects) and SSR_1 the panel sum of squared residuals under H_1 (PSTR model with two regimes), the corresponding F-statistic is then defined by:

$$LM_F = (SSR_0 - SSR_1) / \left[SSR_0 / (TN - N - 1) \right] \tag{11}$$

Under the null hypothesis, the F-statistic has an approximate $F(1, TN-N-1)$ distribution. The logic is similar when it comes to testing the number of transition functions in the model or equivalently the number of extreme regimes. The idea is as follows: we use a sequential approach by testing the null hypothesis of no remaining nonlinearity in the transition function. For instance let us assume that we have rejected the linearity hypothesis. The issue is then to test whether there is one transition function ($H_0: \ r = 1$) or whether there are at least two transition functions ($H_0: \ r = 2$). Let us assume that the model with $r = 2$ is defined as:

$$I_{it} = \alpha_i + \beta_0 S_{it} + \beta_1 \ S_{it} \ g_1(q_{it}; \gamma_1, c_1) + \beta_2 \ S_{it} \ g_2(q_{it}; \gamma_2, c_2) + \epsilon_{it} \tag{12}$$

The logic of the test consists in replacing the second transition function by its first-order Taylor expansion around $\gamma_2 = 0$ and then in testing linear constraints on the parameters. If we use the first-order Taylor approximation of $g_2(q_{it}; \gamma_2, c_2)$, the model becomes:

$$I_{it} = \alpha_i + \beta_0 S_{it} + \beta_1 \ S_{it} \ g_1(q_{it}; \gamma_1, c_1) + \theta_1 \ S_{it} \ q_{it} + \epsilon^*_{it} \tag{13}$$

and the test of no remaining nonlinearity is simply defined by $H_0 : \theta_1 = 0$. Let us denote SSR_0 the panel sum of squared residuals under H_0, i.e. in a PSTR model with one transition function. Let us denote SSR_1 the sum of squared residuals of the transformed model (equation 13). As in the previous examples, the F-statistic LM_f can be calculated in the same way by adjusting the number of degrees of freedom. The testing procedure is then as follows. Given a PSTR model with $r = r^*$, we test the null $H_0 : r = r^*$ against $H_1 : r = r^* + 1$. If H_0 is not rejected the procedure ends. Otherwise, the null hypothesis $H_0 : r = r^* + 1$ is tested against $H_1 : r = r^* + 2$. The testing procedure continues until the first acceptance of H_0. Given the sequential aspect of this testing procedure, at each step of the procedure the significance level must be reduced by a constant factor $0 < \rho < 1$ in order to avoid excessively large models. We assume $\rho = 0.5$ as suggested by Gonzàlez et al. (2005).

4 Data and Results

This study concerns a selection of 24 OECD countries[3] over the period of 1960-2000. Insofar as we aim to stress the time instability of the saving retention coefficient, we consider annual data like did Krol (1996), Coiteux and Olivier (2000), and Jansen (2000) and conversely to FH (1980), Murphy (1984), Feldstein and Bachetta (1991) and Taylor (1994) who used five-year or eight-year averaged cross-section estimations. In light of Krol's (1996), results our sample excludes Luxembourg as suggested by Coiteux and Olivier (2000) and

[3]Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Portugal, South Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

Jansen (2000). Indeed, Jansen (2000) and Coiteux and Olivier. (2000) showed Krol's result of a short-run FH coefficient of 0.20 was essentially due to the presence of Luxembourg in the panel. When Luxembourg is excluded, an unrestricted fixed-effect model estimation, even with annual data, confirms Feldstein and Bachetta (1991)'s result: two-thirds of domestic investment are financed by national saving. Our data are taken from the Penn World Tables, World Development Indicator and the World Perspective database (see Table 1). As recommended by Hansen (1999), we consider balanced panels. As such, we only consider data after 1960. The only exception relates to the current account (data begin in 1970 for: Australia, Austria, Canada, Italy, Netherlands, Sweden, United Kingdom, United States; in 1972 for: New Zealand; in 1974 for: Ireland and Turkey; in 1975: for Belgium, Denmark, Finland, France, Norway, Portugal, Spain; in 1977: for Switzerland; and in 1979 for: Mexico).

We consider six "candidates" for the threshold variable. In the first model (called Model A), we assume that the transition mechanism in the domestic investment equation is determined by GDP per capita growth rate. We are expecting that the stronger the growth, the higher the FH coefficient. The reasoning is as follows: bases of expansion, sustained productivity changes raise not only domestic investment but also national saving (Obstfeld, 1995). In the second specification (Model B), the transition mechanism is based on the degree of openness defined as the ratio of the sum of imports and exports to GDP. That is to say, the more open a country, the more it can borrow from abroad and thus the less domestic investment depends on national saving. The third model (Model C) takes into account the impact of country-size on international mobility of capital. The size of the i^{th} country is approximated by the share of its GDP in current dollars in the total GDP of our sample countries. The larger a country, the higher its saving retention coefficient. Large countries' behaviour influence the global interest rate since a rise in saving can entail a fall in the global interest rate and an increase in domestic investment. This effect has been pointed out by Feldstein and Horioka (1980), Obstfeld (1995), Coakley et al. (1998) and Ho (2003). We also consider two models (Models D and E) in which the transition variable reflects the dependency ratios in the population. We divide the dependency ratio into two sub-ratios: the share of under 15s and over 64s in total population. The greater the number of dependent people (young and old), the smaller the saving rate. However, since ageing pushes investment down, the younger the population is, the higher the rate of investment. Thus, rising youth dependency is expected to increase the saving retention coefficient, whereas ageing will lower it. Finally, we consider (Model F) the ratio of current account to GDP as the threshold variable. Both the intertemporal budget constraint and economic policies of current account targeting are tackled by introducing this variable (see Baxter and Crucini (1993), Obstfeld (1995) and Coakley et al. (1996)). Considering this solvency problem, current accounts cannot diverge too much. As balance of payments' imbalances reflect gaps between domestic investment and national saving, we expect that the greater the absolute value of the current transaction balance, the smaller the FH coefficient.

For each model (i.e. each threshold variable), the first step is to test the linear specification of the capital mobility against a specification with threshold effects. If the linearity hypothesis is rejected, the second step will be to determine the number of transition functions required to capture all the non-linearity, or equally all the FH coefficient heterogeneity. The results of these linearity tests and specification tests with no remaining non-linearity are reported in Table 2. For each specification, we calculate the statistics for the linearity tests LM_f (H_0: $r = 0$ versus H_1: $r = 1$) and for the tests of no remaining non-linearity LM_f (H_0: $r = a$ versus H_1: $r = a + 1$). The values of the statistics are reported up to the first acceptance of H_0. The linearity tests clearly lead to the rejection of the null hypothesis of linearity of the relationships between saving rate and investment rate. Whatever the choice made for the threshold variable, according to the LM_F statistics the null H_0: $r = 0$ is strongly rejected. This first result confirms the non-linearity of the FH relation. The strongest rejection of the null of linearity is obtained when the openness variable model B is used as threshold variable. With a view of selecting a particular model among the six proposed, the "optimal" model would thus be Model B. Indeed, as suggested by Gonzàlez et al. (2005), the "optimal" threshold variable corresponds to the variable which leads to the strongest rejection of the linearity hypothesis.

In the previous specification, the factors are only introduced through the switching functions. However, they may have a direct effect on investments. In fact, if the factors have a direct effect, one could erroneously find switching[4]. In order to check this point, in Table 3, we report the result of the linearity tests obtained in specifications in which the transition variable (growth, openness, size etc.) is also used as an explanatory variable. Under the alternative, the model with direct effect is then defined as:

$$I_{it} = \alpha_i + [\beta_0 S_{it} + \delta_0 q_{it}] + [\beta_1 S_{it} + \delta_1 q_{it}] \;\; g(q_{it}; \gamma, c) + \epsilon_{it} \tag{14}$$

When direct effects are introduced, the linearity test statistics are naturally lower than the values obtained in the baseline case. However, in all cases, even in the model with direct effect, the null of linearity is always strongly rejected.

[4] We are grateful to an anonymous referee for raising this point.

In the same idea, one could argue that if the slope changes in a PSTR model, one would have expected the intercept to change also. In order to check this assumption, we consider a model defined as :

$$I_{it} = \alpha_i + \alpha_0 g(q_{it}, \gamma, c) + \beta_0 S_{it} + \beta_1 S_{it} + \beta_1 g(q_{it}; \gamma, c) + \epsilon_{it} \tag{15}$$

In this specification, if the parameter α_0 is different from zero, the ratio of national investment directly varies with the level of the transition variable. The corresponding estimates are reported in Table 4 for model B only (openness as transition variable)[5]. First, we can observe that the introduction of this intercept switching specification does not change the results of the linearity tests. The null hypothesis of linearity is once again strongly rejected in this case. Second, the estimated value of α_0 is positive and significant. In order to compare the parameter estimates with the results obtained in a simple PSTR model (with fixed effects), we report in the second column of Table 4 the results obtained when the slope changes. As we can observe, the estimated parameters β_0 and β_1 of both models are relatively close. Consequently, the estimated FH coefficients (which corresponds to elasticity) are not globally affected by inclusion of a switching regime intercept.

The specification tests of no remaining non-linearity lead to the identification of an optimal number of transition functions (or extreme regimes) in all cases. The results of these tests are reported in Table 2 for models without direct effect and with individual fixed effects (equation 7). The optimal number of transition functions is always inferior to two. In other words, in a PSTR model, a small number of extreme regimes is sufficient to capture the non-linearity of the saving retention coefficient, or similarly its cross-country heterogeneity and its time variability. However, we should recall that a smooth transition model, even with two extreme regimes ($r = 1$), can be viewed as a model with an infinite number of intermediate regimes. The FH coefficients are defined at each date and for each country as weighted averages of the values obtained in the two extreme regimes. The weights depend on the value of the transition function. So, even if $r = 1$, this model would allow a "continuum" of coefficient values (or regimes), each one is associated with a different value of the transition function $g(.)$ between 0 and 1.

5 PSTR Estimates of Capital Mobility

Table 5 contains the parameter estimates of the final PSTR models. Firstly, we can observe that for all models (except for model C), the estimated slope parameters γ are relatively

[5]The other results are available upon request

small. This implies that the transition function $g(q_{it}; \gamma, c)$ cannot be reduced to an indicator function as in a simple PTR model: the transition between extreme regimes is smooth, except when size is used as the threshold variable. In other words, the estimated values of the capital mobility in this OECD panel cannot be divided into a small number of classes. The estimated FH parameters for OECD countries over the period 1960-2000 are distributed over a "continuum" of values. The great heterogeneity of OECD countries in our sample and the time-decreasing nature of saving retention coefficients lead to this result. It also points to the fact that the solution which consists in grouping countries in sub-panel panels and estimating a homogenous relationship between saving and investment may be unsatisfactory. The only exception is model C. When country size is used to discriminate between economies, the estimated slope parameter is notably high. In this particular case, the transition function is sharp and corresponds to an indicator function. These estimates confirm the results of Ho (2003) based on a PTR model.

Secondly and more importantly, we can evaluate the influence of the six threshold variables on capital mobility. Recall that the estimated parameters β_j cannot be directly interpreted as FH coefficients. As in logit or probit models, the value of the estimated parameters is not directly interpretable, but their signs are. For instance, if we consider model B, the β_1 parameter is negative: it merely implies that when the threshold variable (openness) increases, the FH coefficient decreases (given equation 6). We can then check the influence of the various threshold variables on the FH parameters. Given the sign of the β_1 parameters, our model confirms that the saving retention coefficient will rise as GDP growth is strong, the country is large and the population is young (models A, C and D). However, we also find that openness, ageing and current account inbalances tend to bring down FH coefficient (models B, E and F) and thus to indicate greater international mobility of capital. Although, the main difference from the previous studies is that our model permits to assess the relative quantitative importance of the chosen variables on the relation between investment and saving.

The relative importance of the different threshold variables on the FH coefficient is clearly evident from Figure 2. From these figures, FH coefficients, derived from the six considered PSTR models, are displayed for all the possible values of the transition variable. For each PSTR model (i.e. transition variable), the FH parameter is calculated from equation (6) for any possible theoretical value of q_{it}. In each sub-figure, we depict the average of the threshold variable over the 1960-2000 period for 5 countries (France, Netherlands, Spain, United Kingdom and USA) in order to evaluate their corresponding estimated FH coefficient (evaluated at the mean of q_{it}). These figures clearly indicate that three variables have the greatest influence on the investment-saving relation: the openness, the size of the country and the ratio of current account to GDP. For instance, when the degree of openness is lower than 20%, our model shows that the FH coefficient is equal to 0.85, whereas it is slightly higher than 0.25 when the openness exceeds 100%. Thus, in Figure 2, Netherlands appear to have a significantly smaller saving retention coefficient (0.477) not only in comparison to the USA (0.840), but also to France (0.792) and United Kingdom (0.752) in line with a higher degree of openness. This outcome confirms the reasoning that the more open a country is, the more easily it gains access to international capital markets. Like openness, the ratio of current account to GDP has an important impact on capital mobility: the estimated FH coefficient ranges from 0.75 to 0.35 when the ratio of current account varies from -20% to 15%. This result underlines the importance of the intertemporal budget constraint. On the contrary, the FH coefficient is slightly dependent on the value of the GDP growth rate. For instance, the estimated FH coefficient ranges from 0.49 to 0.61 when the annual GDP growth rate varies from -10% to more than 10%. The results of model C (threshold equal to size) confirm Ho's results. When the relative size of the country is below 4%, the estimated FH coefficient is found to be roughly equal to 0.15, but when the size exceeds this threshold the FH is roughly equal to 0.70 (as in homogenous models in panel). As for dependency ratios, we observe that the higher the proportion of young people in a population, the higher the FH coefficient. As Brooks (2003) put it, a younger population invests more and saves less. In the opposite, ageing drives down the saving retention coefficient, illustrating that as national saving falls, investment has to rely more on foreign saving.

The average estimated FH parameters are reported in Table 6 for the six PSTR models. Contrary to the previous values, these estimated FH parameters are based on the historical values of the transition variable q_{it} observed for the 21 OECD countries. In order to compare our model with linear specifications, we also include the results obtained in time series and in a linear homogenous panel with fixed individual effects. Let us consider the PSTR estimates derived from the optimal model B (openness). The average corresponding FH estimates are quite different from one country to another: the average estimate is only 0.394 in Belgium but is close to 0.840 for the USA. This result clearly points out the heterogeneity of saving retention coefficients. On the other hand, the use of a homogenous linear panel leads to an estimate of 0.655 (valid for all countries), i.e. two thirds of Feldstein and Bachetta (1991): this value is roughly equivalent to the mean of our individual PSTR estimates (0.710), but hides the wide heterogeneity of the sample. On the contrary, using time series reduce the information set and leads to unrealistic and nonsensical values (negative or higher than one) of the FH regression parameters for some countries. This result clearly illustrates the advantage of the panel threshold approach.

With our model, it is also possible to analyse the time dynamics (over the period 1960-2000) of the estimated FH parameters. To this end, we only consider the "optimal" model, i.e. the model with the threshold variable that leads to the strongest rejection of the null linearity hypothesis. We then choose openness as the threshold variable. The individual estimated FH parameters are displayed in Figure 3. These estimates have also been derived from equation (6), but the difference with the previous case (Figure 2) is that here we consider the historical value of the threshold variable q_{it} (openness) observed for each country between 1960 and 2000. Our results confirm the idea of a move towards looser relation between investment and saving. For most of the countries in our sample, the estimated FH parameters decreased between 1960 and 2000. However, we can observe that the fall is generally moderate except for Austria, Belgium, Canada and Ireland.

In summary, we show from various specifications that (*i*) saving retention coefficients are significantly heterogenerous from one country to anther, (*ii*) slightly time decreasing over the period 1960-2000 and (*iii*) three variables (the openness, the size of the country and the ratio of current account to GDP) have the greatest influence on capital mobility. Let us now compare the relative impact of each factor when it is added to a regression already including the four others. Several possibilities exist to include all factors into one model. In this study, we consider a specification with multiple switching functions with different indicators[6]. More precisely, we consider a model defined as:

$$I_{it} = \alpha_i + \beta_0 S_{it} + \sum_{j=1}^{5} \beta_j S_{it} \; g_j(q_{it}^j; \gamma_j, c_j) + \epsilon_{it} \tag{16}$$

where the five transition variables q_1, .., q_5 respectively correspond to openness, GDP growth, country size and two dependency ratios. The last transition variable, i.e. the ratio of current account, has not been considered in order to get a balanced sample. The corresponding parameter estimates and standard errors are reported in Table 7. In particular, for each transition function, the estimates of the slope parameter γ_j, the location parameter c_j and the coefficient of savings β_j are reported. The results confirm previous findings. First, for each transition function, the signs of parameters β_j are the same as

[6]We are grateful to an anonymous referee for this suggestion.

that obtained in the previous specifications with one transition function. The estimated slope parameters are also roughly similar to that obtained in the previous specifications: the transition function associated to the country size corresponds to an indicator function (as in a PTR model), whereas the other transition functions are smooth. The locations parameters are similar to that previously obtained. Second, the most important factors (associated with the larger absolute values of β_j) in this multiple switching specification also correspond to the openness, the size of the country and the ratio of current account to GDP.

6 PSTR Estimates and Endogeneity

In order to assess the robustness of our PSTR estimates to potential endogeneity biases, we propose an instrumental variable (IV) extension of the estimation method generally used in this context. Let us recall that estimating the parameters of a PSTR model is done with non linear least squares. For a given threshold parameter and a given value of the threshold variable, the model is linear and the IV estimator can be adapted in order to take into account the potential endogeneity of savings. Let us consider a simple PSTR model with one transition function ($r = 1$):

$$I_{it} = \alpha_i + \beta_0 S_{it} + \beta_1 S_{it}\ g(q_{it};\gamma,c) + \epsilon_{it} \tag{17}$$

The estimation of the parameters is carried out in two steps. Firstly, the individual effects α_i are eliminated by removing individual-specific means from the variables of the model. This step is standard in linear models (within transformation) but it requires more careful treatment in the context of a threshold model. Let us denote $\tilde{I}_{it} = I_{it} - \bar{I}_i$, where $\bar{I}_i = T^{-1}\sum_{t=1}^{T} I_{it}$. The explanatory and instrumental variables must be transformed as follows. In the first extreme regime, the variable S_{it} is simply transformed as $\widetilde{S}_{it} = S_{it} - \overline{S}_i$ and the instrumental variable as $\tilde{z}_{it} = z_{it} - \bar{z}_i$. However the transformed explanatory and instrumental variables in the second regime depend on the parameters γ and c of the transition function since:

$$\widetilde{w}_{it}\left(\gamma,c_j\right) = S_{it}\, g(q_{it};\gamma,c) - \bar{w}_i\left(\gamma,c\right) \qquad \text{with } \bar{w}_i(\gamma,c) = T^{-1}\sum\nolimits_{t=1}^{T} S_{it}\, g(q_{it};\gamma,c) \tag{18}$$

$$\widetilde{\zeta}_{it}\left(\gamma,c\right) = z_{it}\, g(q_{it};\gamma,c) - \bar{\zeta}_i\left(\gamma,c\right) \qquad \text{with } \bar{\zeta}_i(\gamma,c) = T^{-1}\sum\nolimits_{t=1}^{T} z_{it}\, g(q_{it};\gamma,c) \tag{19}$$

Consequently, the matrix of transformed explanatory variables $x_{it}^{*}\left(\gamma,c\right) = \left[\tilde{S}_{it}\ : \tilde{w}_{it}(\gamma,c)\right]$ and the matrix of instrumental variables $\eta_{it}^{*}(\gamma,c) = [\tilde{z}_{it}\ \ \tilde{\zeta}_{it}(\gamma,c)]$ depend on the parameters of the transition function. Thus we need a recalculation at each iteration. More precisely, given a couple (γ, c), the FH parameter can be estimated by IV, which yields:

$$\begin{aligned} \hat{\beta}_{IV}(\gamma, c) &= \left[\sum_{i=1}^{N}\sum_{t=1}^{T} x_{it}^{*\prime}(\gamma, c)\eta_{it}^{*}(\gamma, c)\left(\eta_{it}^{*\prime}(\gamma, c)\,\eta_{it}^{*}(\gamma, c)\right)^{-1}\eta_{it}^{*\prime}(\gamma, c)\,x_{it}^{*}(\gamma, c)\right]^{-1} \\ &\quad \times \left[\sum_{i=1}^{N}\sum_{t=1}^{T} x_{it}^{*\prime}(\gamma, c)\eta_{it}^{*}(\gamma, c)\left(\eta_{it}^{*\prime}(\gamma, c)\,\eta_{it}^{*}(\gamma, c)\right)^{-1}\eta_{it}^{*\prime}(\gamma, c)\,\tilde{y}_{it}\right] \end{aligned} \quad (20)$$

with $\hat{\beta}_{IV}(\gamma, c) = [\hat{\beta}_0(\gamma, c)\ \hat{\beta}_1(\gamma, c)]'$. During the second phase, conditionally to $\hat{\beta}_{IV}(\gamma, c)$, the parameters of the transition function γ and c are estimated by NLS according to the program:

$$(\hat{\gamma}, \hat{c}) = ArgMin \sum_{i=1}^{N}\sum_{t=1}^{T}\left[\tilde{y}_{it} - \hat{\beta}_{IV}'(\gamma, c)x_{it}^{*}(\gamma, c)\right]^{2} \quad (21)$$

Given $\widehat{\gamma}$ and $\widehat{c}$, it is then possible to estimate the FH coefficient in the extreme regimes as follows: $\hat{\beta}_{IV} = \hat{\beta}_{IV}(\hat{\gamma}, \hat{c})$. We assume that this estimator is convergent even if we have no formal proof for that.

In Table 8, we report the results of this IV estimation for three models (models B, D and E). For each model, we consider two other instrumental variables which correspond to the threshold "candidates" not used as the threshold variable. For instance, in model B the threshold is openness, and we use two instrumental variables: ratios of under 15s and of over 64s in total population. We observe that the estimated parameters are similar to the parameters reported in Table 3. More precisely, we observe that the individual average FH coefficients (Table 6) derived from these PSTR estimates corrected for endogeneity are relatively close to the estimated FH coefficients based on non corrected PSTR. Our results seem therefore to offset the presence of endogeneity. This result can be interpreted as follows: using a PSTR limits the potential endogeneity bias, since for each level of threshold variable there is a "particular" value of the estimated FH regression parameter.

7 Conclusion

In this paper we put forward an empirical evaluation of the influence of various threshold variables on the saving-retention coefficient. This assessment is based on a Panel Smooth Transition Regression Model. In summary, our results raised three main points. Firstly the relationship between domestic investment and saving is non linear. This conclusion is robust to changes in the threshold variable and to potential endogeneity biases. In particular, we found that three variables have the greatest influence on saving retention coefficients: the degree of openness, the size of the country and the ratio of current account to GDP. In addition, for five out of the six models, it seems that the saving retention coefficient for OECD countries cannot be divided into a small number of classes and must be studied through a model allowing a "continuum" of regimes. This result reveals the strong heterogeneity in the degree of mobility of OECD countries. Secondly in keeping with existing literature, we see that the estimated FH parameters fall between 1960 and 2000 for most countries in our sample. Thirdly, we present an original method which identifies the heterogeneity and time variability of the FH coefficient.

Table 1: Property of the Data

Series	N	Obs.	Mean	Std.	Min.	Max.	Source
Ratio of Investment	24	960	25.53	5.94	9.79	44.8	Penn World
Ratio of Save	24	960	24.86	6.93	0.19	41.8	Penn World
Openness	24	960	54.20	27.4	6.66	163	Penn World
Growth	24	936	2.781	3.13	-9.51	13.5	Penn World
$pop_{<15years}$	24	960	25.06	6.78	14.3	46.5	World Perspective
$pop_{>64years}$	24	960	11.11	3.54	3.27	17.9	World Perspective
Size	24	960	4.11	7.94	0.03	40.0	World Perspective
Cur. Account	24	639	-0.981	3.67	-16.1	15.4	World Development Indicator

Notes: Our data are issued from the Penn World Tables, World Developement Indicator and the World Perspective (The data come from Sherbrooke University. This database is built from statistics of World Bank, United Nations, OECD and others institutions. For more detail see : http://perspective.usherbrooke.ca.) Ratio of investment : Investment Share of real gross domestic product per capita (CGDP). The component shares of real GDP for 1996 are obtained directly from a multilateral Geary aggregation over all the countries. Ratio of save : This variable is defined as the percentage share of current savings to GDP and is derived by subtracting Consumption Share of CGDP, and Government Share of CGDP, from 100. Openness: Exports plus Imports divided by real gross domestic product per capita is the total trade as a percentage of GDP. Growth : growth rate of Real GDP per capita (Chain). Pop14 : Population ages 0-14 (% of total). Pop 15 : Population ages 65 and above (% of total).Current account: Current account balance (% of GDP) . Current account balance is the sum of net exports of goods and services, income, and current transfers

Table 2: LM_f Tests for Remaining Nonlinearity

Model	Model A	Model B	Model C
Threshold Variable	Growth	Openness	Size
H0 : r = 0 vs H1 : r = 1	73.08 (0.00)	293.1 (0.00)	6.54 (0.01)
H0 : r = 1 vs H1 : r = 2	0.637 (0.42)	0.071 (0.79)	0.48 (0.49)
H0 : r = 2 vs H1 : r = 3	-	-	-
Model	Model D	Model E	Model F
Threshold Variable	$pop_{<15years}$	$pop_{>64years}$	Cur. Account
H0 : r = 0 vs H1 : r = 1	186.5 (0.00)	211.1 (0.00)	141.3 (0.00)
H0 : r = 1 vs H1 : r = 2	3.21 (0.07)	0.075 (0.78)	0.006 (0.94)
H0 : r = 2 vs H1 : r = 3	-	-	-

Notes: For each model (*i.e.* for each threshold variable), the testing procedure works as follows. First, test a linear model ($r = 0$) against a model with one threhosld ($r = 1$). If the null hypothesis is rejected, test the single threshold model against a double threshold model ($r = 2$). The procedure is continued until the hypothesis no additional threhold is not rejected. The corresponding LM_F statistic has an asymptotic $F[1, TN - N - (r + 1)]$ distribution under H_0. The corresponding p-values are reported in parentheses.

Table 3: LMF Tests for Remaining Linearity with Direct Effects

Model	Model A	Model B	Model C
Threshold Variable	Growth	Openness	Size
H0 : r = 0 vs H1 : r = 1	36.44 (0.00)	62.93 (0.00)	15.75 (0.00)
Model	Model D	Model E	Model F
Threshold Variable	$pop_{<15years}$	$pop_{>64years}$	Cur. Account
H0 : r = 0 vs H1 : r = 1	31.40 (0.00)	35.15 (0.00)	3.28 (0.04)

Notes: For each model (*i.e.* for each threshold variable), the LM_F statistics of linearity tests are reported for specifications with direct effect. In this case, the transition variable is also used as an explanatory variable. The corresponding LM_F statistic has an asymptotic $F[K, TN - N - (r+1)K]$ distribution under H_0, where K is the number of explicative variables. In this specification with direct effect, we have $K = 2$. The corresponding p-values are reported in parentheses.

Table 4: Test for Remaining Nonlinearity and Parameter Estimates: Specification with Switching Intercept

	Model B: Transition Openess	
	Fixed Effects	Switching Intercept
H0 : r = 0 vs H1 : r = 1	293 (0.00)	149 (0.00)
Constant α_0	-	10.8 (1.36)
Parameter β_0	0.885 (0.02)	0.854 (0.02)
Parameter β_1	-0.678 (0.03)	-0.543 (0.05)
Location Parameters c	87.2	62.7
Slopes Parameters γ	0.037	0.462

Notes:The specification fixed effects corresponds to a standard PSTR model. The specification with switching constant corresponds to PSTR in which the constant term is affected by the transition function. For both models, the LM_F statistics of linearity tests are reported for specifications. The corresponding p-values are reported in parentheses.

Table 5: Parameter Estimates for the Final PSTR Models

Specification	Model A	Model B	Model C	Model D	Model E	Model F
Threshold Variable	Growth	Openness	Size	$pop_{<15years}$	$pop_{>64years}$	Cur. Account
r^*	1	1	1	1	1	1
Parameter β_0	0.487	0.885	0.292	0.378	0.600	0.893
	(0.04)	(0.02)	(0.05)	(0.03)	(0.04)	(0.08)
Parameter β_1	0.126	-0.678	0.492	0.215	-0.371	-0.676
	(0.01)	(0.03)	(0.05)	(0.01)	(0.02)	(0.07)
Location Parameters c	2.74	87.2	0.52	20.7	14.2	-2.63
Slopes Parameters γ	0.774	0.037	73.58	0.579	0.547	0.109
AIC Criterion	2.102	1.907	2.068	1.957	1.939	1.700
Schwarz Criterion	2.123	1.927	2.068	1.978	1.959	1.730
Number of obs.	936	960	960	960	960	639

Notes: The standard errors in parentheses are corrected for heteroskedasticity. For each model, the number of transition functions r is determined by a sequential testing procedure (see Table 1). For each transition function, the estimated location parameters c and the corresponding estimated slope parameter γ are reported. The PSTR parameters can not be directly interpreted as elasticities.

Table 6: Individual Estimated Capital Mobility

Model	OLS / Within		Model A		Model B		Model C		Model D		Model E		Model F	
Threshold Variable			Growth		Openness		Size		$pop_{<15years}$		$pop_{>64years}$		Cur. Account	
	β	σ	$\bar{\beta}$	$\bar{\sigma}$	$\bar{\beta}$	$\bar{\sigma}$	$\bar{\beta}$	$\bar{\sigma}$	$\bar{\beta}$	$\bar{\sigma}$	$\bar{\beta}$	$\bar{\sigma}$	$\bar{\beta}$	$\bar{\sigma}$
Australia	0.874	(5.85)	0.546	(3.43)	0.808	(1.19)	0.784	(0.00)	0.562	(3.61)	0.564	(2.57)	0.570	(3.07)
Austria	0.933	(6.49)	0.554	(3.67)	0.668	(6.60)	0.784	(0.00)	0.484	(6.79)	0.407	(4.48)	0.532	(3.14)
Belgium	0.897	(10.3)	0.553	(3.59)	0.394	(10.4)	0.784	(0.00)	0.485	(6.35)	0.423	(5.62)	0.481	(5.36)
Canada	0.615	(7.66)	0.550	(3.86)	0.740	(5.93)	0.784	(0.00)	0.54	(5.33)	0.565	(2.92)	0.549	(2.96)
Denmark	1.044	(20.6)	0.543	(3.90)	0.690	(2.89)	0.784	(0.00)	0.478	(7.25)	0.436	(7.35)	0.549	(2.96)
Finland	1.723	(23.9)	0.555	(4.19)	0.735	(4.11)	0.784	(0.00)	0.502	(6.41)	0.516	(6.60)	0.523	(6.49)
France	1.077	(9.72)	0.550	(3.62)	0.792	(2.34)	0.784	(0.00)	0.526	(5.26)	0.451	(5.13)	0.503	(2.10)
Greece	0.956	(3.13)	0.554	(4.78)	0.787	(2.80)	0.773	(1.91)	0.514	(7.10)	0.478	(8.68)	0.569	(3.40)
Iceland	1.022	(12.3)	0.554	(4.76)	0.642	(3.86)	0.292	(0.00)	0.586	(0.95)	0.568	(1.84)	0.553	(4.69)
Ireland	0.091	(4.20)	0.564	(4.02)	0.479	(13.2)	0.292	(0.00)	0.587	(1.44)	0.544	(0.71)	0.558	(8.61)
Italy	1.099	(6.54)	0.553	(3.95)	0.788	(2.37)	0.784	(0.00)	0.496	(8.13)	0.465	(9.85)	0.509	(3.31)
Japan	0.850	(5.87)	0.565	(4.21)	0.833	(0.68)	0.784	(0.00)	0.514	(7.73)	0.540	(8.29)	0.471	(2.28)
Mexico	-0.152	(19.8)	0.540	(3.92)	0.805	(4.46)	0.784	(0.00)	0.594	(0.00)	0.599	(0.03)	0.553	(5.70)
Netherlands	1.313	(20.1)	0.546	(3.25)	0.477	(6.51)	0.784	(0.00)	0.514	(7.50)	0.527	(4.26)	0.455	(3.03)
New Zealand	0.526	(20.3)	0.534	(4.27)	0.737	(3.14)	0.292	(0.03)	0.578	(1.93)	0.565	(2.13)	0.603	(5.98)
Norway	-0.067	(28.6)	0.557	(3.42)	0.631	(2.43)	0.784	(0.00)	0.516	(5.73)	0.414	(7.73)	0.504	(9.24)
Portugal	0.342	(10.2)	0.569	(4.32)	0.717	(5.07)	0.368	(8.78)	0.539	(7.18)	0.520	(7.34)	0.568	(7.61)
South Korea	0.600	(4.72)	0.591	(3.51)	0.719	(7.43)	0.784	(0.00)	0.584	(1.94)	0.599	(0.12)	0.515	(8.18)
Spain	1.074	(13.8)	0.557	(4.50)	0.804	(2.87)	0.784	(0.00)	0.532	(7.91)	0.509	(8.77)	0.531	(3.27)
Sweden	1.031	(15.1)	0.543	(3.55)	0.713	(5.62)	0.784	(0.00)	0.457	(3.73)	0.361	(8.89)	0.516	(3.37)
Switzerland	1.327	(11.0)	0.532	(3.49)	0.677	(3.81)	0.784	(0.00)	0.478	(7.25)	0.466	(6.91)	0.425	(4.77)
Turkey	1.049	(7.95)	0.549	(4.57)	0.821	(3.39)	0.784	(0.00)	0.594	(0.03)	0.599	(0.05)	0.536	(3.33)
United Kingdom	0.720	(11.1)	0.541	(3.25)	0.752	(2.69)	0.784	(0.00)	0.501	(5.43)	0.414	(6.99)	0.521	(3.49)
USA	1.280	(13.6)	0.550	(3.66)	0.840	(0.78)	0.784	(0.00)	0.554	(3.26)	0.539	(3.13)	0.527	(2.30)
All Countries	0.655	(2.15)	0.552	(4.06)	0.710	(12.5)	0.704	(17.7)	0.529	(6.86)	0.502	(8.95)	0.526	(6.17)

Notes: For each country, the average $\bar{\beta}$ and standard deviation $\bar{\sigma}$(in percentages) of the individual capital mobility are reported. The two first column of the line *All countries* corresponds to the within estimates.

Table 7: Parameter Estimates for the Multiple Switching Transition Functions PSTR Model

transition	$\hat{\beta}$	Slope parameter	Location parameter
none	0.354 (4.19)	-	-
Openness	-0.303 (3.91)	0.047	91.35
Growth	0.103 (1.03)	0.648	2.083
$pop_{<15years}$	0.031 (1.20)	98.87	19.73
$pop_{>64years}$	-0.173 (2.84)	0.650	14.28
Size	0.261 (3.36)	198.4	0.491

Notes: The multiple switching transition function PSTR model corresponds to a model with five transition functions. Each transition function is associated to a specific transition variable. For the j^{th} transition function, the slope parameter γ_j, the location parameter c_j and the cofficient of savings β_j are reported. The standard errors in parentheses are corrected for heteroskedasticity

Table 8: Parameter Estimated for the Final PSTR Models corrected of endogeneity

Specification	Model B	Model D	Model E
Threshold Variable	Openness	$pop_{<15years}$	$pop_{>64years}$
Instrumental variables	$pop_{<15years}$, $pop_{>64years}$	Openness, $pop_{>64years}$	Openness, $pop_{<15years}$
r^*	1	1	1
Parameter β_0	0.787 (0.04)	0.391 (0.06)	3733 (330)
Parameter β_1	-0.559 (0.04)	0.211 (0.02)	-7464 (660)
Location Parameters c_1	98.1	21.2	3.94
Slopes Parameters γ	0.058	0.566	$1.6 * 10^{-5}$

Notes: The standard errors in parentheses are corrected for heteroskedasticity. For each model,the number of transition functions r is determined by a sequential testing procedure (see Table 1). For the j^{th} transition function, with $j = 1, ..r$, the estimated location parameters c_j and the corresponding estimated slope parameter γ_j are reported. The PSTR parameters can not be directly interpreted as elasticities.

Table 9: Individual Estimated Capital Mobility corrected of endogeneity

Model	OLS / Within		Model B		Model D		Model E	
Transition variable	-		Openness		$pop_{<15years}$		$pop_{>64years}$	
Instrumental variables	Openess, $pop_{<15years}$, $pop_{>64years}$		$pop_{<15years}$, $pop_{>64years}$		Openness, $pop_{>64years}$		Openness, $pop_{<15years}$	
	β	σ	$\bar{\beta}$	$\bar{\sigma}$	$\bar{\beta}$	$\bar{\sigma}$	$\bar{\beta}$	$\bar{\sigma}$
Australia	0.931	(7.15)	0.776	(0.33)	0.563	(4.19)	0.550	(4.08)
Austria	0.962	(7.81)	0.702	(4.92)	0.483	(6.41)	0.412	(2.76)
Belgium	1.380	(19.2)	0.402	(13.13)	0.484	(6.07)	0.421	(3.55)
Canada	0.59	(9.78)	0.746	(3.73)	0.540	(5.87)	0.556	(5.03)
Denmark	3.382	(97.3)	0.724	(1.84)	0.479	(6.83)	0.433	(4.98)
Finland	1.706	(34.8)	0.747	(2.11)	0.502	(6.62)	0.506	(7.19)
France	1.132	(13.2)	0.771	(0.70)	0.524	(5.49)	0.439	(3.29)
Greece	0.979	(3.96)	0.769	(0.88)	0.515	(6.94)	0.468	(7.47)
Iceland	1.147	(13.3)	0.688	(3.32)	0.591	(1.28)	0.552	(3.35)
Ireland	0.095	(4.47)	0.503	(15.5)	0.593	(1.82)	0.510	(0.83)
Italy	1.192	(7.47)	0.770	(0.74)	0.498	(7.70)	0.456	(7.48)
Japan	0.969	(26.0)	0.782	(0.14)	0.516	(7.52)	0.553	(9.49)
Mexico	-0.883	(35.9)	0.773	(1.72)	0.602	(0.00)	0.717	(0.95)
Netherlands	2.986	(57.6)	0.506	(8.47)	0.517	(7.67)	0.502	(4.30)
New Zealand	-0.976	(110)	0.749	(1.52)	0.581	(2.44)	0.549	(3.83)
Norway	0.470	(40.9)	0.680	(2.13)	0.514	(5.85)	0.417	(5.04)
Portugal	0.146	(53.2)	0.737	(2.75)	0.543	(7.35)	0.509	(7.00)
South Korea	0.559	(5.16)	0.733	(4.00)	0.590	(2.40)	0.715	(2.97)
Spain	1.311	(21.0)	0.774	(0.92)	0.537	(7.91)	0.499	(7.55)
Sweden	1.622	(28.6)	0.733	(3.50)	0.455	(3.27)	0.376	(6.27)
Switzerland	1.648	(15.1)	0.714	(2.64)	0.479	(6.83)	0.454	(5.14)
Turkey	1.419	(24.3)	0.778	(0.96)	0.602	(0.05)	0.707	(1.29)
United Kingdom	0.914	(16.0)	0.756	(1.13)	0.498	(5.35)	0.417	(4.46)
USA	1.480	(19.8)	0.783	(0.13)	0.554	(3.89)	0.512	(3.63)
All Countries	0.683	(0.04)	0.712	(10.9)	0.531	(6.99)	0.510	(10.5)

Notes: For each country, the average $\bar{\beta}$ and standard deviation $\bar{\sigma}$(in percentages) of the individual capital mobility are reported. The two first column of the line *All countries* corresponds to the within estimates..

Figure 1: Transition Function with c=0. Sensivity Analysis to the Slope Parameter γ

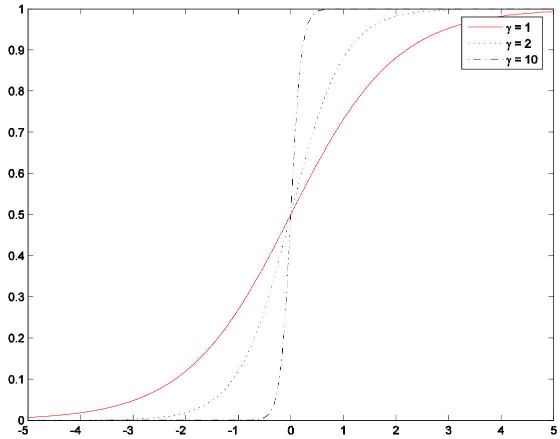


Figure 2: Estimated FH Coefficients PSTR Models

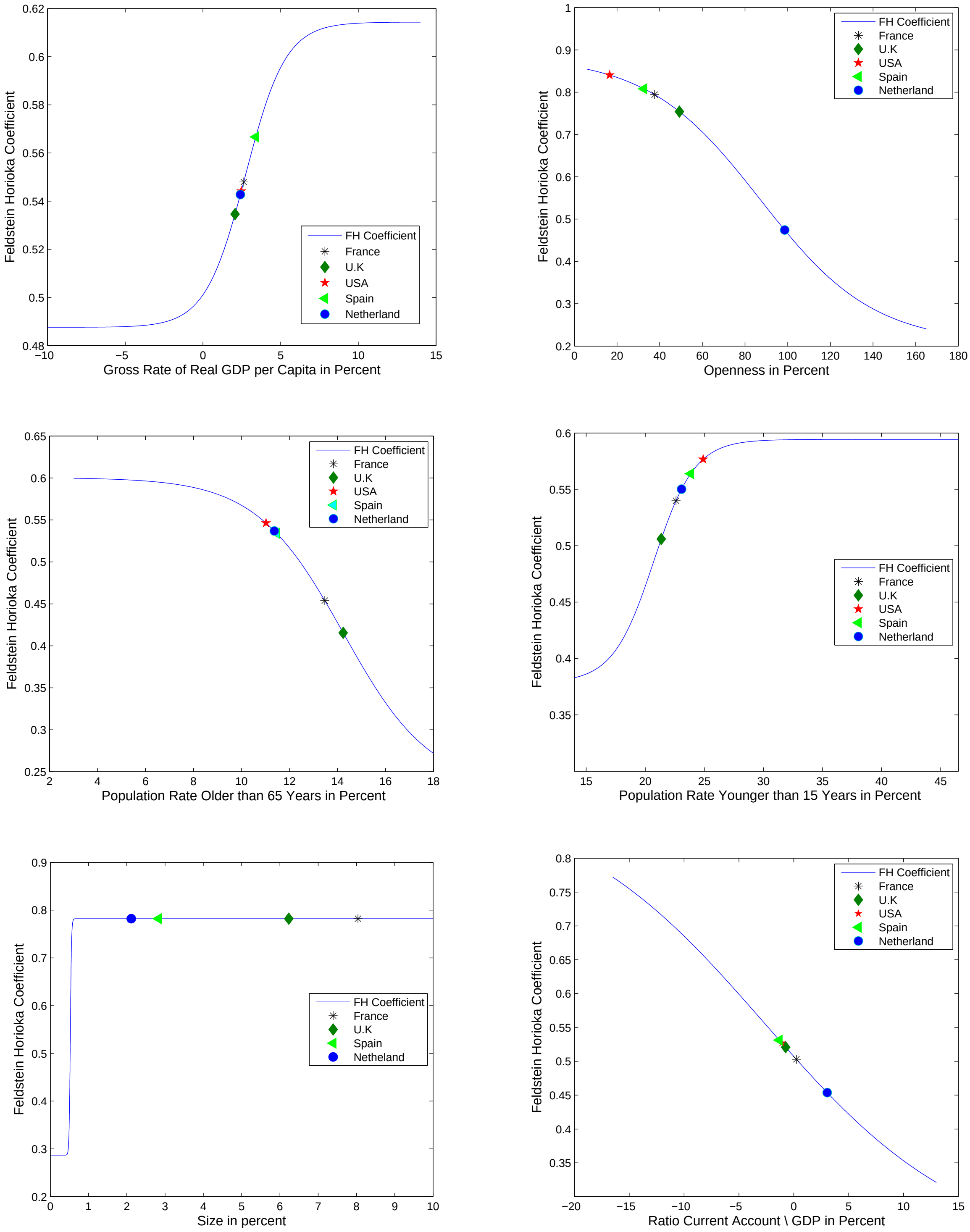
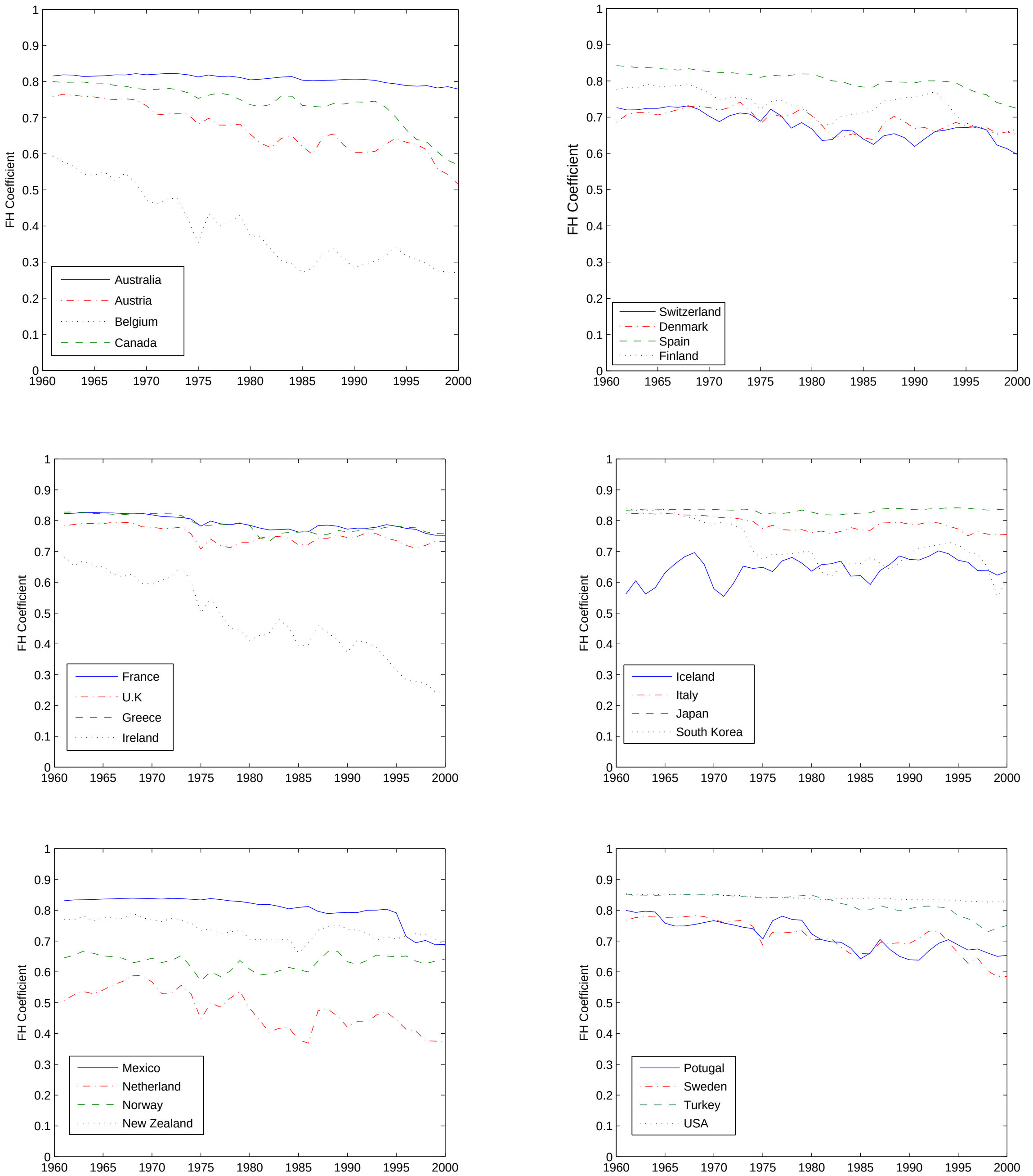


Figure 3: Estimated FH Individual Coefficients: PSTR Model B



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